Aug. 30, 1932. R. H. WAPPLER 1,874,672

X-RAY SHIELD

Filed May 1, 1923 4 Sheets-Sheet 1

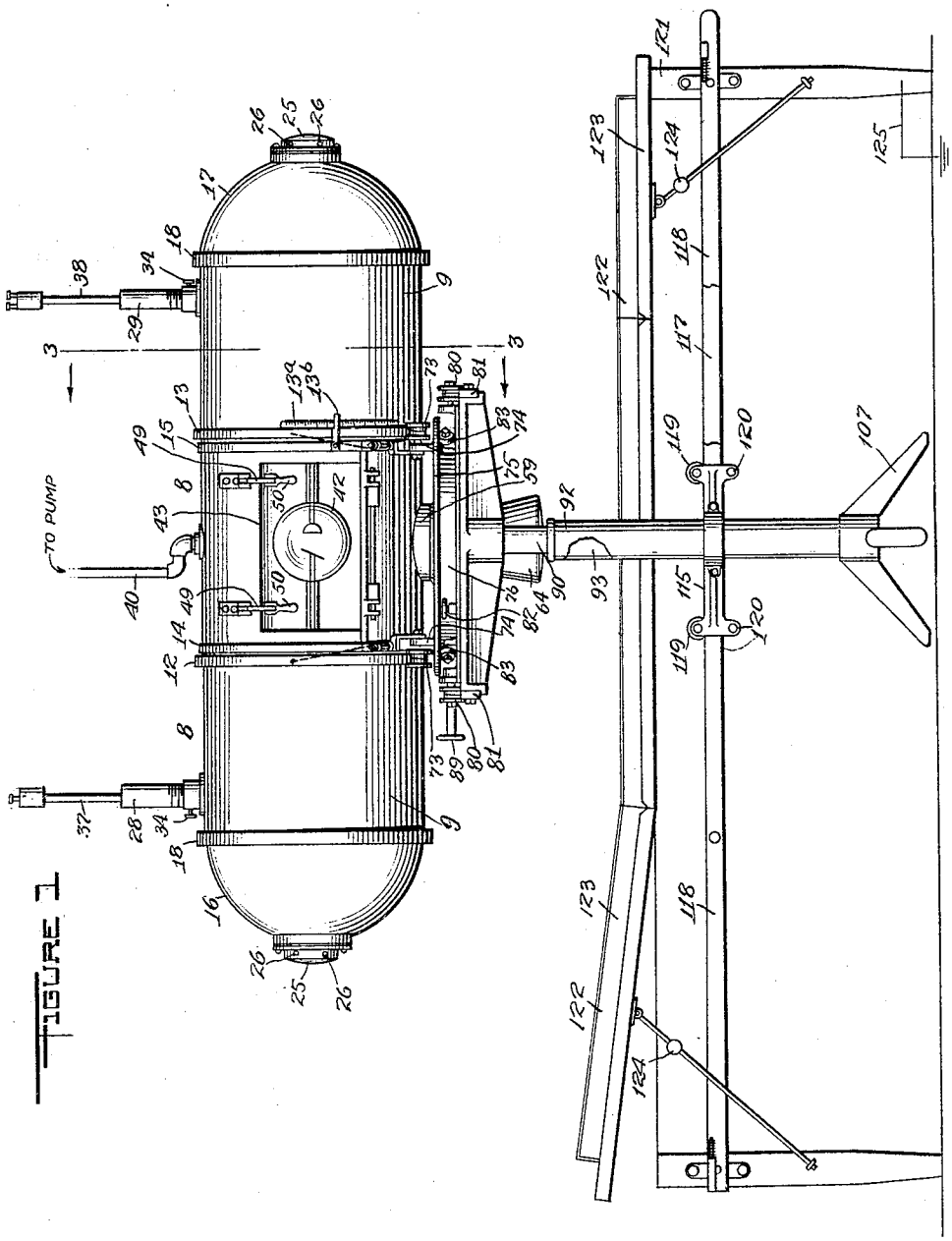


FIGURE 1

INVENTOR
Reinhold H. Wappler

BY Walton Harrison,
his ATTORNEY

WITNESS
M. E. Lessin

Aug. 30, 1932. R. H. WAPPLER 1,874,672

X-RAY SHIELD

Filed May 1, 1923 4 Sheets-Sheet 2

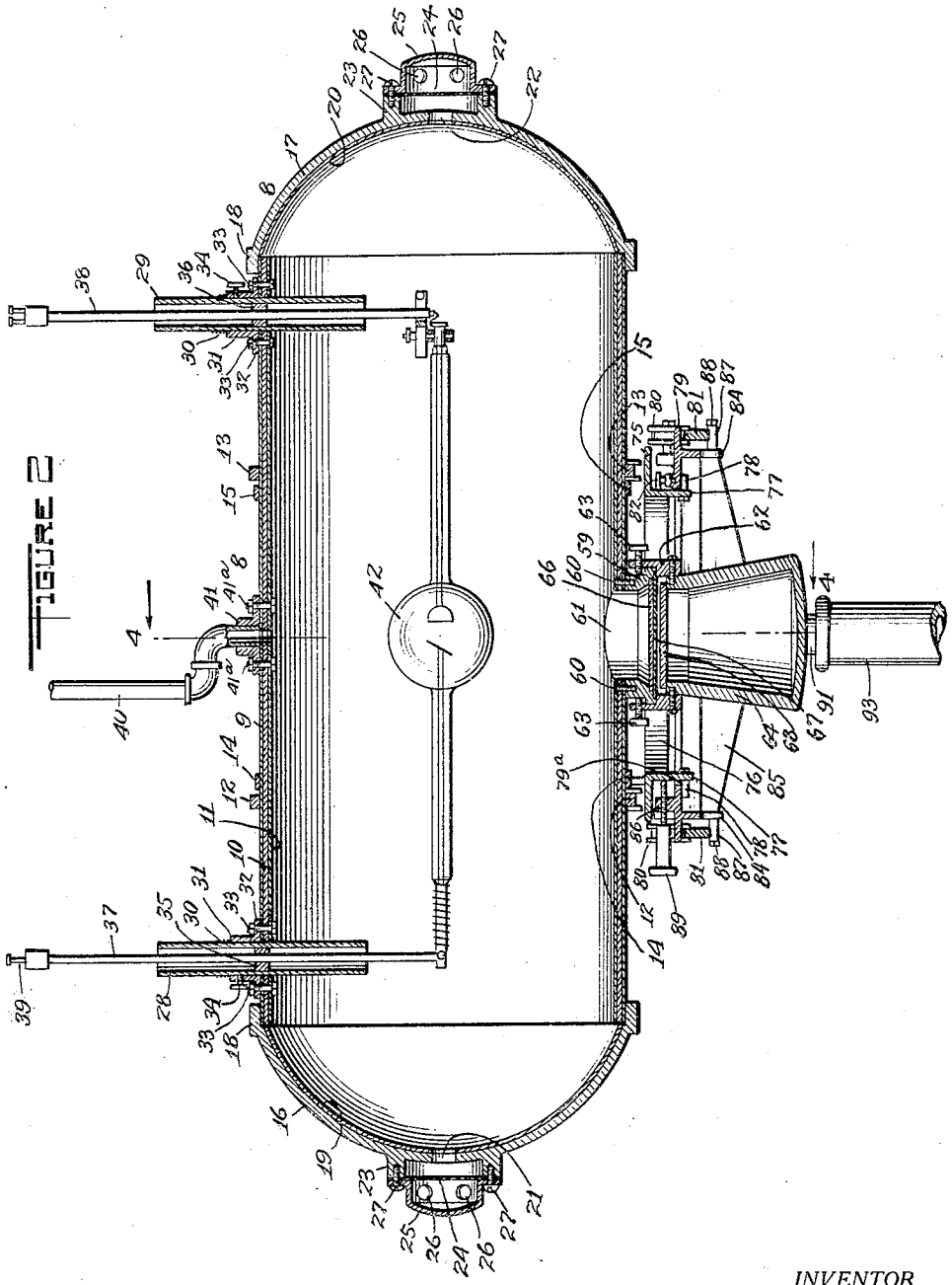


FIGURE 2

INVENTOR
Reinhold H. Wappler

BY Walton Harrison
his ATTORNEY.

WITNESS
M. E. Lessin

Aug. 30, 1932. R. H. WAPPLER 1,874,672

X-RAY SHIELD

Filed May 1, 1923 4 Sheets-Sheet 3

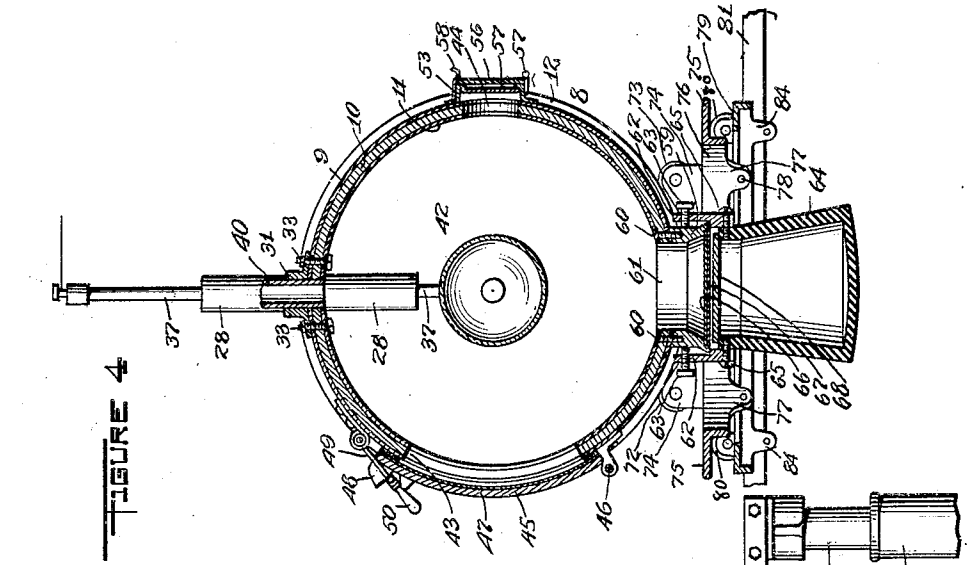


FIGURE 4

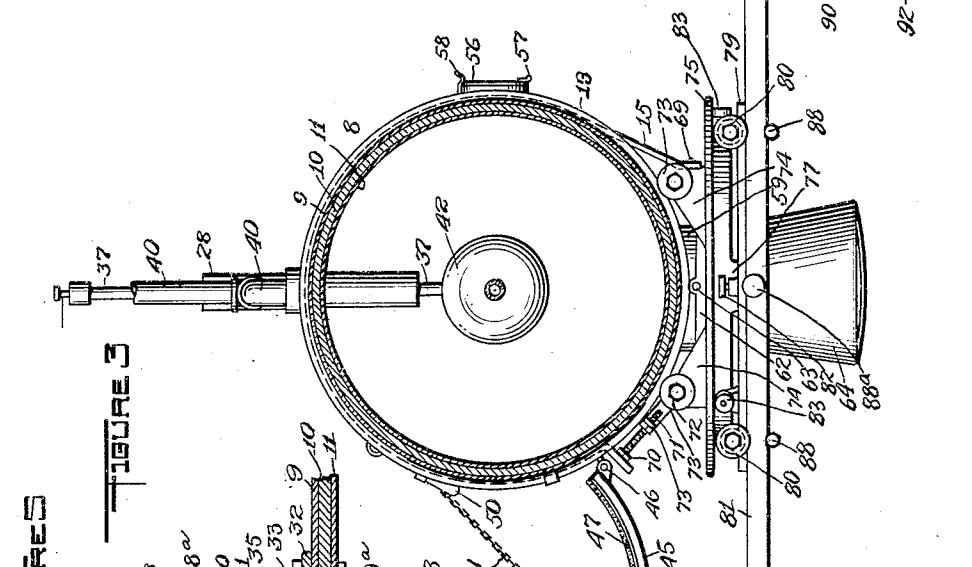


FIGURE 3

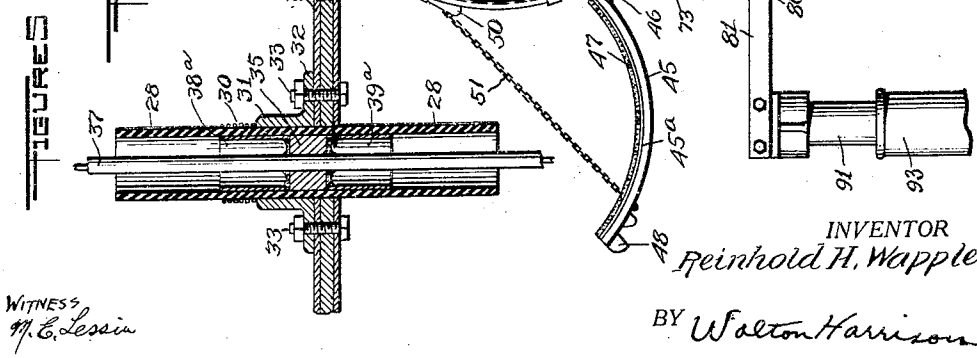


FIGURE 5

INVENTOR
Reinhold H. Wappler

BY Walton Harrison

his ATTORNEY.

WITNESS
M. E. Lessin

Aug. 30, 1932. R. H. WAPPLER 1,874,672

X-RAY SHIELD

Filed May 1, 1923 4 Sheets-Sheet 4

FIGURE 7

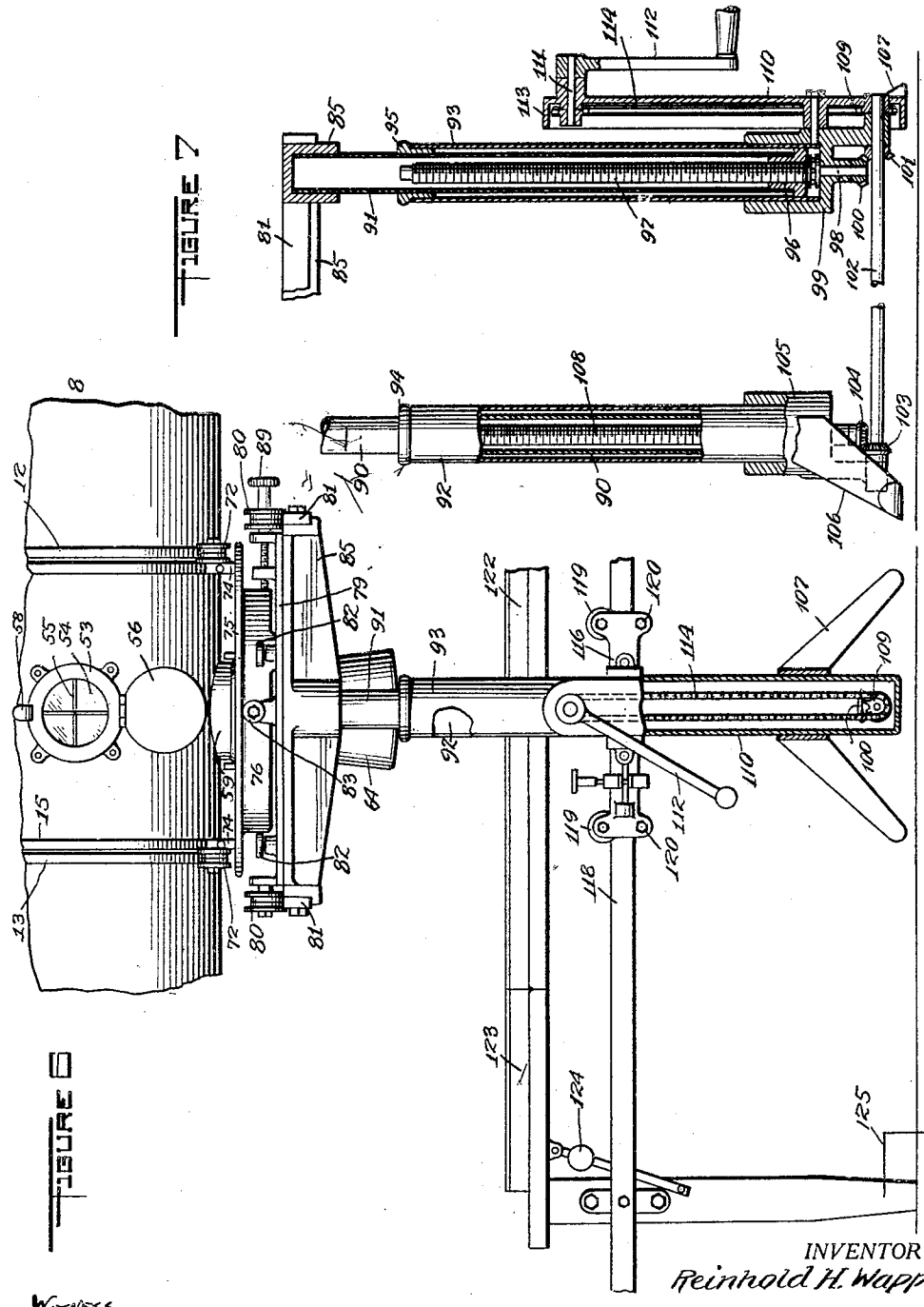


FIGURE 6

INVENTOR
Reinhold H. Wappler

BY Walton Harrison,
his ATTORNEY

WITNESS
M. E. Lessin

Patented Aug. 30, 1932 1,874,672

UNITED STATES PATENT OFFICE

REINHOLD H. WAPPLER, OF YONKERS, NEW YORK, ASSIGNOR TO WAPPLER ELECTRIC COMPANY, INC., OF LONG ISLAND CITY, NEW YORK, A CORPORATION OF NEW YORK

X-RAY SHIELD

Application filed May 1, 1923. Serial No. 635,857.

My invention relates to X-ray shields of the type in which the shield is of substantially tubular form and in which the X-ray tube is contained within the shield, so as to protect the patient, the operator and any bystanders present, from the undesirable effects of the X-rays.

More particularly stated, my invention comprehends a number of distinct objects, as follows:

I. To provide a protective shield for enclosing the X-ray tube, this shield consisting entirely of metal built up in layers and so arranged as to provide adequate protection to bystanders as against the X-rays, and to afford sufficient mechanical strength for the purposes here contemplated, as well as to render sufficiently rapid the cooling of the exterior of the X-ray tube.

II. To ground this X-ray shield, so that a patient or a bystander coming into contact with the shield receives no electrical shock; and by using this grounded shield in connection with means for exhausting the air from the shield, to easily remove the vitiated and heated air from within the casing and discharge the same outside, this being impossible with a shield which is ungrounded.

III. To give the metallic shield such form that while the X-ray tube is housed within the shield and is in action the electrical stresses are substantially uniform upon different portions of the X-ray tube, and so that outside fields, either electrostatic or electromagnetic in character, are unable to produce uneven stresses such as tend to cause punctures to take place in the tube.

IV. To employ in connection with the shield, insulators of improved form, so located as to extend through the wall of the shield and so arranged that when high tension impulses are conducted through the insulators to the X-ray tube, no uneven fields of stress are thereby set up around the X-ray tube.

V. To render the tube shield adjustable into an infinite number of relative positions, so as to enable a patient resting on the table to be exposed to the X-rays at an infinite number of different angles, and so that various parts of the patient's body may be conveniently subjected to the treatment of rays from the X-ray tube, without placing the patient in uncomfortable positions.

VI. To so form, construct and arrange the X-ray tube and insulators used in immediate connection therewith as to decrease the danger of electrical breakdowns, or the formation of oscillations, or the diversion of current impulses applied to the X-ray tube.

It is a fact, well known in this art, that metals high in the series of atomic weights are the one most effective for protecting patients and bystanders against the action of X-rays, and naturally the metal most widely used for the protective purposes here contemplated is lead. However, on account of its softness lead has not sufficient mechanical strength for a shield which is to be portable and adapted to be shipped. For this reason I prefer to use a lead cylinder supported by a cylinder of steel, though a cylinder of any other metal having sufficient strength for the purpose may be employed to support the lead cylinder. With the lead cylinder and the cylinder of strong metal for supporting the same, I employ another cylinder enclosing the two concentrically and made of copper, aluminum or other metal which is a good conductor of heat and which is adapted to receive and retain an elegant finish.

It is a fact not generally recognized in this art that although the insulation between a casing and an X-ray tube contained therein may be improved by enlarging the casing, there are in practice severe limitations to prevent undue enlargement of the casing; such as rendering the structure unwieldy and increasing disproportionately the expense of construction. One purpose of my invention is to confer upon the casing such form that a given enlargement of the casing gives a maximum of insulation efficiency. I do this by rendering the ends of the casing substantially hemispherical, thus rendering all parts of its inner surface equi-distant from the nearest contiguous portion of the X-ray tube.

Heretofore in this art there has been much difficulty in providing and maintaining good insulation between the casing used as an X-ray shield and the electrodes leading into the

casing for the purpose of energizing the X-ray tube. It has been usually found in practice that in order to obtain the required insulation it was necessary to use tubular insulators of considerable length and large size, thus leading to many undesirable complications. I seek to equip the casing with insulators of improved construction and arrangement, so as to obtain a maximum of good insulation while allowing the apparatus to be made compact, and without unduly increasing the cost of the mechanism.

In practical X-ray work it is desirable that the operator can quickly and easily obtain access to the X-ray tube, and that the casing containing the tube and used as a screen may be readily adjustable into various positions relatively to the operating table and to various other parts with which the work of the X-ray tube is associated. On this account I seek to give the casing such form, construction and arrangement that the operator can easily and quickly turn the casing from one position to another, and I provide means for enabling the operator to lock the casing in the new positions into which it is thus moved.

Reference is made to the accompanying drawings forming a part of the specification, and in which like reference characters indicate like parts throughout the several figures.

Figure 1 is a side elevation of my device as used in connection with an X-ray table.

Figure 2 is a substantially central longitudinal section through the casing and parts immediately associated therewith.

Figure 3 is a section on the line 3—3 of Figure 1, looking in the direction indicated by the arrows.

Figure 4 is a section on the line 4—4 of Figure 2, looking in the direction indicated by the arrows, and showing certain movable parts occupying positions different from those occupied by the same parts in Figure 3.

Figure 5 is a section similar to a portion of Figure 2, but upon a somewhat larger scale.

Figure 6 is a fragmentary side view, partly in elevation and partly in section, showing various parts associated with the casing for facilitating the handling thereof.

Figure 7 is a fragmentary section showing a portion of the gearing used for raising and lowering the casing with its contents.

The casing as a whole is indicated by the reference letter 8. A copper cylinder 9, a lead cylinder 10 and a steel cylinder 11 are nested together concentrically, the lead cylinder being fitted snugly into the copper cylinder and the steel cylinder being fitted into the lead cylinder, so that the three metallic cylinders are practically merged into a single cylinder composed of three thicknesses of metal. The composite cylinder thus formed carries a pair of annular rails 12, 13. Adjacent these are a pair of steel straps 14, 15, used as hereinafter described.

Located at the ends of the composite cylinder are end caps 16 and 17, each of substantially hemispherical form. These end caps are provided with linings 19 and 20, made of lead and each having a substantially hemispherical form, thus fitting neatly into the end cap and being practically a part thereof. The end caps together with their linings are provided with air holes 21 and 22, and with raised beads 23 of annular form encircling these holes. A pair of filter members 24, made of gauze, felt, cloth or the like, are fitted upon the annular beads 23 and held in position thereupon by caps 25, these caps being provided with inlet holes 26, and held in position by screws 27 or equivalent fastenings.

Extending radially into the casing 8 are a pair of insulating members 28 and 29, each made of micanite or other suitable insulating material and carrying a packing 30. The insulating members 28 and 29 extend through collars 31; these collars each being provided with a flange 32 and held in position by bolts 33, which extend through this flange and through the wall of the casing. The insulating members 28 and 29 are adjustable in the sense that they may each be moved in the direction of their length, or in other words moved radially inward and outward relatively to the casing. The insulating members 28 and 29, when thus adjusted, are held firmly in position by clamping screws 34 extending through the walls of the collar 31. Located within the tubular members 28 and 29 are a pair of supporting rings 35 and 36, exactly alike. These rings support insulating conductors 37 and 38, which extend lengthwise through the tubular insulating members 28 and 29. Engaging these rings 35 and 36 are tube packings 38^a and 39^a, made of soft rubber and each having a form which may be understood more particularly by reference to Figure 5.

An air pipe 40 is connected with the casing 8 by aid of a collar 41, secured in position by means of bolts 41^a. The air pipe 40 is connected with an air pump, not shown, but indicated by the legend "To Pump," appearing in Figure 1. When the air pump is in operation it continuously draws the air out of the casing, and the air constantly enters the casing through the holes 26 and through the filter member 24. Thus the air is effectively filtered as it passes into the casing, so that there is a constant circulation of air through the casing. The purpose of this arrangement is threefold: first, to remove the air heated up by the X-ray tube and thus to maintain a relatively low temperature in the X-ray tube and parts contiguous thereto; second, to remove the air as it becomes ionized by action of the X-rays an is thus rendered more or less conductive; and third, to prevent the X-ray tube from contaminating the surrounding atmosphere.

The casing is provided with a large opening 43 and a smaller opening 44, these openings serving as doorways and being disposed diametrically opposite each other, as may be understood from Figure 4.

Located adjacent the opening 43 is a door 45, mounted upon hinges 46 as indicated in Figures 3 and 4, and provided internally with a lining 45a of lead and with a facing 47 of felt. The door 45 carries lugs 48. Two clasps 49 are journaled upon the casing, and are each adapted to engage a pair of the lugs 48 in order to hold the door closed, as indicated in Figure 4. Each clasp 49 is provided with a handle 50, whereby it is operated. Connected with the door 45 are a pair of chains 51, which are also connected with the casing. These chains limit the travel of the door as the same is swung open, as may be understood from Figure 3. Mounted rigidly upon the casing, and disposed adjacent the opening 44, is a supporting ring 53 carrying a small eye piece 54, this eye piece having the form of a disk and being made of glass or other transparent material. The eye piece carries a pair of crossed wires, used as hereinafter described.

A small door 56, having the form of a disk, is mounted upon the supporting ring 53 by means of a hinge 57. The door 56 may be opened and closed by hand. When closed it is held by a latch 58, as indicated in Figure 4. The door is shown in Figure 6 as swung downwardly, or open. With the door in this position the operator can look through the eye piece 54 into the casing.

Mounted upon the lower portion of the casing, and extending downwardly therefrom, is a supporting ring 59, held in position by screws 60. The casing is provided with an opening 61 which is in registry with the opening through the supporting ring 59. Another supporting ring 62 encircles the supporting ring 59, and is secured thereupon by bolts 63. A compression cone appears at 64 and is secured to the supporting ring 62 by screws 65. A number of filter plates are shown at 66, 67 and 68, and are held in position by the supporting ring 62 and by the compression cone 64.

Each strap 14 and 15 is secured at one of its ends by a fastening 69, at its opposite end is provided with an outwardly extending flange portion 70. This portion is connected with a turnbuckle 71, secured to a bolt 72, and used for tightening the strap. The annular rails 12, 13 rest upon and are guided by rollers 73. There are four of these rollers, and they are journaled upon four lugs 74 which are integral with, and extend upwardly from, a supporting ring 75. The supporting ring 75 is disposed horizontally, and is provided with an annular portion 76, extending downwardly. This annular portion is provided with flanges 77 integral with it and extending downwardly from its lower edge. Guide pins 78 are carried by these flanges, and extend radially outward therefrom, as may be understood from Figure 2.

A carriage frame appears at 79, and is provided with a large opening 79a of circular form, through which extends the annular portion 76 of the supporting ring 75.

Journaled upon the carriage frame 79 are supporting rollers 80, which rest upon a pair of rails 81, extending horizontally and disposed parallel with each other. Journaled upon the carriage 79 are guide rollers 82, which engage the outer surface of the portion 76 of the supporting ring, as may be understood more particularly from Figure 6. The rollers 82 are in this instance three in number and are arranged in the same plane, which is horizontal. Journaled upon the carriage 79 are three supporting rollers 83, which engage the under side of the supporting rings 75, as may be understood from Figure 1.

The carriage 79 is provided with four lugs 84 extending downwardly from it, as indicated in Figure 4. A plurality of pins 88 project outwardly from the lugs 84 and are surrounded by loose collars or rollers 87. Longitudinal movement of the rollers 87 relative to the pins 88, is prevented by the head of the pin and the lugs 84.

The carriage 79 is provided with a clamping screw 89, extending through a lug 86, as may be understood from Figure 2.

The operator by turning the screw 89 can lock the supporting ring 75 rigidly in position relatively to the carriage frame 79. By loosening the screw 89 he leaves the supporting ring 75 loose relatively to the carriage frame so that the supporting ring and parts carried by it may be turned relatively to the carriage frame. Thus the operator, by adjusting the supporting ring 75 relatively to the carriage frame, can turn the casing 8 as a whole relatively to various other parts.

The carriage 79 and all parts carried thereby, including the casing 8, may as a unit be moved back and forth along the rails 81. Thus the operator can to all intents and purposes shift the position of the casing relatively to the length of the rails 81.

With the carriage thus brought into position and for the time being locked against further movement, the operator can turn the casing 8 upon its longitudinal axis, and lock it into the position which it is thus turned. For this purpose the operator first actuates the turn buckles 70, thereby loosening the straps 14 and 15. This done he turns the casing by hand, either in a clockwise direction or a counter-clockwise direction according to Figures 3 and 4, and again actuates the turn buckles so as to tighten the straps 14 and 15. The movements just described are quite easily effected, even though the

casing 8 may be quite heavy. This is because the entire weight of the casing and its contents rests upon the roller 73.

The casing carries a graduated strip 13ª, and a pointer 13ᵇ is mounted upon the strap 15. These two parts together constitute a scale for registering the position of the casing relatively to the strap 15, or in other words enables the operator to read off the extent to which the casing is turned from a predetermined normal position. Therefore the operator can so adjust the casing as to bring the doorways 43 and 44, as well as the compression cone 64, into different positions. He can also turn the casing into suitable position to promote the accessibility of the electrical connections used for energizing the X-ray tube.

The cross beams 85 are mounted rigidly upon a pair of tubular telescopic members 90 and 91, which extend vertically into two larger telescopic members 92 and 93 and are fitted into bushings 94 and 95 carried thereby, as may be understood from Figure 7. The tubular telescopic member 91 is at its lower end provided with a nut 96 of annular form, which is secured rigidly to the telescopic member and thus movable bodily therewith. Extending through this nut and into the tubular member 91 is a screw 97, provided with a portion 98 having a reduced diameter and serving as a shaft. The parts just mentioned are journaled in a bearing 99. The shaft 98 carries a bevel gear 100, which meshes with another bevel gear 101. The bevel gear 103 meshes with a bevel gear 104, the latter having the same relation to a screw 108 that the bevel gear 100 has to the screw 97. The screws 97 and 108 are turned in opposite directions, as may be understood from Figure 7. The tubular member 92 is supported by a bearing 105, and connected with this bearing is a pedestal 106. The tubular member 92 carries a similar pedestal 107.

The shaft 102 carries a sprocket wheel 109 whereby it is turned, as may be understood from Figure 7. A gear casing 110 is mounted rigidly upon the bearing 99, and projects upwardly therefrom. Extending into the gear casing 110 and journaled thereto is a shaft 111, carrying a crank arm 112. The shaft 111 also carries a sprocket wheel. Engaging this sprocket wheel is a sprocket chain 114, which also engages the sprocket wheel 109, carried by the shaft 102.

The operator, by rotating the crank arm 112 by hand, causes the various gear members controllable thereby to turn the two screws 97 and 108 in opposite directions as above described, thus causing the tubular members 90 and 91, controllable practically as a unit, to be raised or lowered. By this means the carriage and all parts supported thereby, and including the casing 8, are raised and lowered as the operator may desire.

The telescopic members 92 and 93 are supported upon two slides 115 and 116, as shown in Figures 1 and 6 respectively, these slides being mounted upon and supported by a pair of rails 117 and 118. Each slide 115 and 116 carries rollers 119 which engage the top edge of the rails supporting the slide, and also carries guide pins 120 which engage the bottom edge of the rail.

The rails 117 and 118 are mounted upon a table 121. This table is provided with a couch 122 and a head rest 123, so that a patient may recline upon the couch, with his head upon the head rest. By means of an adjusting device 124, the head rest may be adjusted in the manner well known in this art.

The table is connected with the ground at 125, and as the table and practically all parts of the framework are made of metal, the X-ray tube is in metallic communication with the earth at 125.

As may be readily understood from the foregoing description the X-ray shield consists entirely of metal which is built up in layers and so arranged as to provide adequate protection as against the X-rays to operatives and bystanders. The X-ray shield has sufficient mechanical strength for all practical purposes, and provision is made for the rapid cooling of the X-ray tube.

Since the table upon which the patient rests is grounded, so that the X-ray shield is grounded through the same earth connection, there is no danger of either the patient or any other person receiving a shock because of coming into contact with the X-ray shield. Moreover, the grounding of the X-ray shield has a singular effect in connection with the exhaust apparatus, in that it enables the vitiated and heated air within the X-ray shield to be easily removed and carried outside. This result is not accomplished if the X-ray shield is left ungrounded.

Just why the grounding of the X-ray shield enabled the vitiated and heated air to be readily removed in a matter not easily explained. However, the fact here noted is borne out in practice.

Because of the form of the metallic shield above described it follows that with the tube enclosed in the shield and in action, the various electrical and magnetic surfaces are so distributed as to be uniform relatively to different portions of the X-ray tube. The result is that extrinsic fields, either electrical or magnetic, are unable to produce uneven fields of stress such as usually tend to break or puncture an X-ray tube.

Since the current impulses used for energizing the tubes are conducted into the shield by means of the tubular insulators above described, these insulators, because of their

form and arrangement, have a tendency to prevent uneven stresses around the X-ray tube.

It will be noted that the X-ray shield can be so used as to expose a patient, resting upon the table, to the action of X-rays reaching the patient from many different directions. It will also be noted that various parts of the patient may be conveniently subjected to the action of the X-rays without the necessity of placing the patient in any uncomfortable position.

The construction and arrangement of the X-ray shield and the tubular insulators used therewith are such as to decrease to a minimum the danger of electrical breakdowns, the formation of oscillations, and the diversion of currents transmitted to the X-ray tube.

The operator, by moving the slides 115 and 116 relatively to the rails 117 and 118, can move the casing 8 and the carriage supporting the same into various positions relatively to the length of the X-ray table.

I do not limit myself to the particular construction described and illustrated, as variations may be made therein without departing from my invention, the scope of which is commensurate with my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:

1. The combination of an X-ray shield having a general cylindrical form and built up of a plurality of different metals, said X-ray shield having its ends rounded to prevent the formation of uneven electrical stresses within it, and an X-ray tube located within said X-ray shield and having its ends extending approximately to the center of curvature of the rounded ends of said X-ray shield.

2. In an X-ray screen the combination of a plurality of substantially cylindrical members made of different metals nested concentrically to form a composite cylindrical member, a pair of substantially hemispherical end caps made of metal for closing the ends of the composite cylindrical member thus formed, and means for supporting an X-ray tube within said cylindrical member, in spaced relation to said end caps.

3. The combination of a supporting member, a plurality of rollers mounted upon said supporting member, annular rails resting upon said rollers and movable relatively to said supporting member, an X-ray shield of substantially cylindrical form extending through said annular rails and supported thereby upon said rollers, an X-ray tube mounted within said X-ray shield, and means for conducting high tension currents to said X-ray tube.

4. In a device the combination of an X-ray shield of substantially cylindrical form, annular rails encircling said X-ray shield, supporting rollers engaging said annular rails and thus supporting said X-ray shield to permit said X-ray shield to be turned upon its general longitudinal axis, mechanism adapted to be connected with said X-ray shield and controllable by the operator for locking said X-ray shield in different positions into which it may thus be turned, and an X-ray tube mounted centrally within said X-ray shield.

5. A device comprising an X-ray shield of substantially cylindrical form, rails of substantially annular form carried by said X-ray shield and encircling the same, supporting rollers engaging said annular rails and supporting the weight of said annular rails and said X-ray shield, to allow said X-ray shield to be turned into different positions, straps encircling said X-ray shield and connected with a fixture, and means controllable at the will of the operator for loosening and tightening said straps.

6. A device comprising an X-ray shield having the form of a substantially cylindrical casing, an X-ray tube mounted within said casing lengthwise in the general direction of the axis thereof, a supporting ring located below said X-ray shield and supporting the weight thereof, rollers engaging said supporting ring and thus supporting the weight of said casing, mechanism adapted to be connected with said supporting ring for locking the same in different positions into which said supporting ring may be turned.

7. In an X-ray device, a tubular container, an X-ray tube extending axially within said container, and a carrier in which said container is mounted to turn about the axis of the container and of the tube, said carrier being adjustable in a direction transverse to said axis.

8. In X-ray apparatus, an X-ray tube, an envelope substantially surrounding said tube, the body of said envelope consisting substantially of two cylinders of conducting material whose longitudinal axes are substantially parallel with the longitudinal axis of the X-ray tube, said cylinders being telescoped one within the other, the space between said cylinders being filled with material opaque to X-rays.

9. In X-ray apparatus, an X-ray tube, an envelope substantially surrounding said tube, the body of said envelope consisting substantially of two cylinders telescoped one within the other, the space between said cylinders being filled with material opaque to X-rays, and hemispherical ends for closing the ends of said cylinders.

Signed at Long Island City, in the county of Queens and State of New York, this 27th day of April, 1923.

REINHOLD H. WAPPLER.